96
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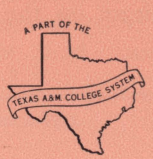
# Commercial Storage and Handling of Sorghum Grain




THE AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS
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IN COOPERATION WITH THE
U. S. DEPARTMENT OF AGRICULTURE

# Summary


Three areas that provide a cross section of physical and economic conditions under which sorghum grain is produced, handled and stored were selected for study of storage and handling facilities and practices by commercial grain storage operators. The High Plains produces slightly less than half, the North Central area about one-fourth and the Coastal Bend less than one-tenth of the sorghum grain grown in Texas.

Commercial storage space in the State more than doubled during 1955-60. Grain stocks in storage increased even more rapidly. Storage space in 1955 was 71 percent occupied on January 1, whereas the much greater space in 1960 was 82 percent occupied. Grain sorghum increased from less than half to almost three-fourths of total grain stored. More than four-fifths of stored sorghum grain in 1960 was under loan or forfeited to CCC and more than one-fourth was more than 2 years old.

About one-fifth of the grain storages in Texas are over 1-million-bushel capacity and slightly less than one-fourth are from one-half to 1 million bushels. The 259 million bushels of additional storage space built during 1955-60 in the areas studied were about evenly divided between additions to facilities already existing in 1955 and new storages. There was a marked shift from upright to flat storage and from the use of concrete to steel in storage structures. The shift was caused mainly by lower initial investment costs, ease of construction, potential for greater portability, anticipation of more flexibility in use and rapid adoption of aeration systems particularly adaptable to flat storage operations.

Most of the sorghum grain handled by storages on the High Plains was moved to terminals and other storages, although exports and sales to feeders and truckers were important outlets. Exports, shipments to terminals and other storages, and sales to feed mills were important outlets in North Central Texas; exports were the major outlet in the Coastal Bend.

About four-fifths of the sorghum grain receipts at storages were by truck, but three-fourths of the shipments out were by rail. There was a noticeable increase during 1955-59 in the proportion of both receipts and shipments moved by truck. About three-fourths of the storages had receiving capacities of 1,500 to 12,000 bushels per hour and slightly less than a third were 3,000 to 6,000 bushels. Most of the operators had similar capacities for loading out as for receiving. Labor requirements for handling receipts increased as the conveyor capacity increased but not proportionately. Consequently, those with receiving capacities in excess of 8,000 bushels per hour required less than one-third as much labor per 1,000 bushels of receipts as those with less than 4,000 bushels per hour. The High Plains had higher capacities for receiving and loading out by comparable size storages than the other two areas.

All storages run moisture tests when receiving grain and more than 90 percent inspect for condition. A larger proportion in North Central Texas than in the other two areas also tests for foreign matter, tests weight, insects and the general condition of the grain. Only about one-third of the operators segregated grain sorghum and most of them did so on the basis of moisture, although some indicated insect infestation and foreign matter were used as a basis.

Many operators set maximum moisture contents above 13 percent at which they will accept grain without a drying charge, and operators on the High Plains tend to have higher maximums acceptable without drying charge than in the other two areas. Drying equipment is practically universal among storages in the Coastal Bend. About three-fourths of the storages on the High Plains have dryers compared with less than one-fourth in North Central Texas. The continuous flow drier is twice as numerous as the batch type.

All storages in the Coastal Bend and nine-tenths of those in the other areas were equipped to aerate part or all their stored grain. More than four-fifths of the storage space in the Coastal Bend was equipped for aeration compared with slightly less than two-thirds in the other two areas. About one-fourth of the storages had automatic temperature sensing systems while others relied on deep bin probes and other methods of determining grain temperatures.

Most storage operators fumigate their stored sorghum grain and a majority do it themselves although slightly less than one-fourth hire commercial firms. A majority of the operators in the Coastal Bend and North Central Texas use their aeration system for fumigation while almost half of those on the High Plains use gravity.

# Commercial Storage and Handling of Sorghum Grain

Clarence A. Moore and Charles W. Brown*

A PRODUCTION EXPLOSION OF SORGHUM GRAIN in the past two decades, accompanied in the 1950's by large increases in carryover stocks, has taxed facilities for moving, handling, storing and marketing the crop. The Texas crop is a large proportion of the nation's total production. With Gulf port shipping points for export at Houston, Galveston and Corpus Christi, the State is a focal point of handling and storage problems facing the sorghum grain industry.

The average annual sorghum grain production for the United States increased from 56 million bushels in the late 1930's to 442 million in the late 1950's. The 1960 crop was estimated at almost 620 million bushels. Texas annual production averaged 30 million bushels in the late 1930's, 212 million in the late 1950's and about 258 million bushels in 1960.

Carryover stocks in the nation increased from less than 8 million bushels in 1953 to about 582 million in 1960. This almost equaled the 585 million bushels produced in 1959.

Off-farm grain storage facilities in Texas registered phenomenal increases, especially during the 1950's. This was largely in response to increased production and carryover stocks of sorghum grain, although increased production and carryover of other grains also required additional space. Commercial grain storage space increased from 105 million bushels in 1945 to 680 million bushels in 1960. It was estimated at 768 million bushels in January 1961.

The expansion in storage facilities was accomplished in part by operators undertaking new ventures who were initially limited in knowledge and experience of grain storage operations. In addition there occurred changes in utilization patterns, in the market structure, in functions performed by storage installations and in the use of better equipment and techniques in handling, storing and preserving sorghum grain in storage. Thus, even the experienced storage operators faced new situations.

Aeration was developed and flat storage installations became more feasible and a more prominent part of commercial storage facilities as a consequence. There has been constant pressure to harvest grain at a higher moisture content to reduce field losses. Drying facilities at storage installations have become more common in the High Plains in the past 6 years. Some storage operators feel the advent of hybrid sorghums, and increased irrigation of sorghums, intensified the problem of preserving the grain in storage.

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## SCOPE AND PROCEDURE

This is one of two studies on storage and marketing of Texas sorghum grains. The first was a study of marketing patterns and on-farm storage by sorghum producers. This portion covers the marketing, storage and handling practices of local commercial storage operators. The third study will analyze alternative storage, drying, aeration and fumigation practices and evaluate their relative efficiencies and costs.

The present study was designed to determine (1) the movement pattern of sorghum grain into and out of storage, (2) the relative importance of total sorghum grain and CCC and carryover stocks of sorghum in the use of storage space, (3) the facilities

## CONTENTS

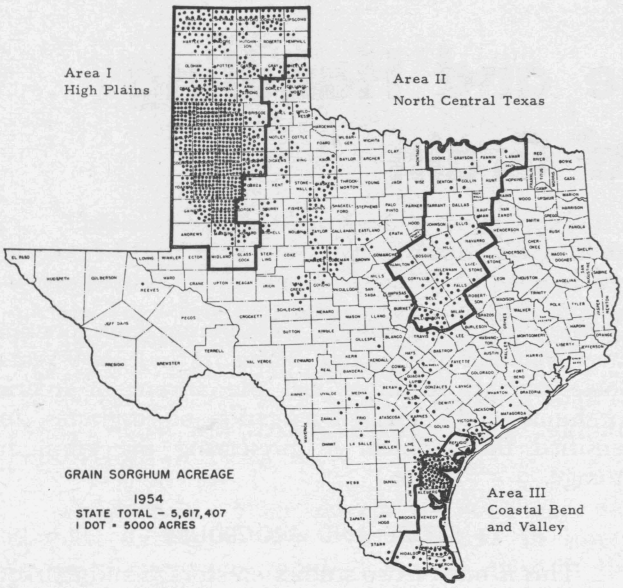


**Figure 1. Sorghum grain producing areas studied.**

for handling, drying and storing grain and (4) the practices used in receiving, loading out and maintaining the quality of stored grain. *The purpose was to determine and describe changes in conditions and practices in recent years, rather than prescribe what they should be under assumed efficiency conditions.*

Three areas of the State were delineated for study, Figure 1, to provide a representative cross-section of the widely varying physical and economic conditions under which production, marketing and storage of sorghum grains are conducted. A brief description of each area is provided so the results may be compared with other areas and states.

### High Plains Area

Area I, the High Plains, is the heaviest sorghum grain producing area in the State. Most of the area has an elevation from 3,000 to 4,000 feet. Its level topography is well suited to large acreage and mechanized farming operations. It is characterized by low precipitation, low relative humidity and relatively hot summer and cold winter temperatures. Winter temperatures below freezing are common. Since harvest occurs from September through November, the temperature of new grain moving into storage is not high.

Sorghum grain production is well established. It expanded from 54 to 166 million bushels during 1949-59. There is considerable irrigation where underground water supplies are available. Sorghum grain is grown under both dryland and irrigated conditions.

Sorghum grain competes with wheat for storage space in the northern part of the area. In 1949 sorghum grain contributed 35 percent and wheat 63 percent to total grain production. In 1959 the proportions were 70 percent for sorghum grain and 27 percent for wheat. Small amounts of oats and barley are grown.

Sorghum is the main grain crop in the southern part of the area. It contributed 88 percent in 1949 and 96 percent in 1959 to total grain production. Most of the increase in acreage of sorghum grain in the High Plains during the 1950's was on acreage diverted from wheat in the northern part and on acreage diverted from cotton in the southern part.

Commercial storage space in the High Plains increased from 51 million bushels in 1949 to 271 million bushels in 1959. The storage space was less than half as large as total grain production in 1949 but was 27 percent greater than grain production in 1959. Storage space further increased to about 381 million bushels by 1961, 40 percent greater than in 1959.

An increasing proportion of total commercial storage space has been in larger units. None of the storage approved by CCC under the Uniform Grain Storage Agreement in 1949 was larger than 2.5-million-bushel capacity; whereas, 28.5 percent of the space in 1959 and 39 percent of the space in 1961 was in units over 2.5-million-bushel capacity.

The high ratio of storage space to grain production in 1959, further increase of 40 percent in storage space by 1961, and the increasing proportion of total storage space in large units suggests that operators of grain elevators in the area depend to a considerable extent on carryover stocks and grain shipped in from other states (anticipating later export from Gulf port shipping points) to fill their facilities.

### North Central Texas

Most of area II, North Central Texas, is between 500 and 1,000 feet elevation. Annual precipitation averages between 35 and 45 inches. However, because of its interior position, the relative humidity is more moderate than it is in the Coastal Bend. Minimum January temperatures at weather stations in the area fall below zero and below freezing temperatures are common. Most of the sorghum grain is harvested in August and September.

Sorghum grains compete with corn, oats and wheat for storage facilities. Total grain production increased from about 37 million bushels in 1949 to 60 million bushels in 1959. Sorghum grain increased from one-tenth of the total in 1949 to four-tenths in 1959, and wheat remained about the same at one-tenth of total production. Corn production declined from about half of the total grain produced in 1949 to slightly less than three-tenths in 1959, and oats from three-tenths to two-tenths of the total. Expansion of sorghum grain acreage during the 1950's occurred primarily on land diverted from cotton and corn.

Commercial storage space increased from 41 million bushels in 1949 to 144 million bushels in

1959. It increased another 20 percent to 172 million bushels by 1961. The expansion in storage installations occurred in all size groups. Those less than 500,000 bushels capacity contributed about 16 percent to total capacity in recent years compared with 11 percent in 1949.

Carryover stocks and movements of grain from other areas have influenced storage expansion. However, the high ratio of storage space to grain production in the area is influenced by the large grain storage installations in Fort Worth that have functioned permanently as secondary marketing facilities between local storage installations, from whom they receive grain, and mill and export buyers. Storage installations in excess of 2.5-million-bushel capacity contributed about 56 percent to total storage space in North Central Texas in both 1949 and 1959.

### Coastal Bend

The elevation of most of area III, the Coastal Bend, is less than 250 feet. Annual rainfall averages only 20 to 26 inches but its nearness to the Gulf causes relative humidity to be a serious problem. Summer temperatures are high, and winter temperatures relatively mild. Minimum temperatures recorded at the different weather stations in the area are above zero and below freezing temperatures in winter are rare. Harvest occurs in June and July. New crop sorghum grain moving into storage has at least 2 months of high outside temperatures.

Total grain production, which consists almost altogether of sorghum grain, increased from less than 9 million bushels in 1949 to 30 million in 1959. Sorghum grain had its advent as a major crop in the area after widespread use of the combine, and varieties suitable for combine harvesting, were established in the late 1930's and early 1940's. Acreage expansion was mostly on acres diverted from cotton.

Most storage facilities are comparatively new. Commercial storage approved by CCC was less than 1-million-bushel capacity in 1949. It increased to 13-million-bushel capacity in 1959, 10 percent greater than grain production in the area that year. Only about 3 million bushels of space were added from 1959-61. Much of the increase in storage space was by units less than 1-million-bushel capacity. The expansion of storage facilities was probably more a response to increasing local grain production than to grain shipments from other areas. Some of the larger facilities at Corpus Christi are secondary grain facilities rather than local storage installations and serve the export trade.

### Procedure

A random sample of commercial storage installations was drawn in each area and data were obtained by personal interview of managers or other responsible personnel. The 92 storage units studied were about 17 percent of all commercial grain storage installations in the three areas. Higher percentages for samples in North Central Texas and the Coastal Bend were advisable because of the smaller number of storage installations in those areas.

TABLE 1. SAMPLE AND TOTAL NUMBER OF STORAGE INSTALLATIONS BY SIZE GROUPS

| Area | Number and proportion by size | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | All sizes | Less than 500,000 bushels | | 500,000-999,000 bushels | | 1,000,000-2,499,999 bushels | | 2,500,000 bushels and above | |
| | No. | No. | % | No. | % | No. | % | No. | % |
| High Plains | | | | | | | | | |
| Total | 351 | 175 | 50 | 81 | 23 | 74 | 21 | 21 | 6 |
| Sample | 46 | 19 | 41 | 13 | 28 | 11 | 24 | 3 | 7 |
| North Central | | | | | | | | | |
| Total | 174 | 115 | 66 | 34 | 20 | 16 | 9 | 9 | 5 |
| Sample | 27 | 15 | 56 | 5 | 18 | 4 | 15 | 3 | 11 |
| Coastal Bend | | | | | | | | | |
| Total | 50 | 24 | 48 | 17 | 34 | 8 | 16 | 1 | 2 |
| Sample | 19 | 7 | 39 | 10 | 50 | 2 | 11 | | |
| All areas | | | | | | | | | |
| Total | 575 | 314 | 55 | 132 | 23 | 98 | 17 | 31 | 5 |
| Sample | 92 | 41 | 45 | 28 | 30 | 17 | 18 | 6 | 7 |

A check of sample units against all units by size categories showed the sample to represent the total as shown in Table 1. Information from sample elevators on amounts of different kinds of grain in storage, although not precisely comparable in point of time to Crop Reporting Estimates of storage stocks, were not inconsistent with those estimates for the 1960 season. Thus, checks on size and kinds of grain stored showed sample elevators with a pattern similar to all elevators in each of the three areas studied.

Information from the Agricultural Stabilization and Conservation Service and the State Crop and Livestock Reporting Service was used to supplement data obtained by field interview.

## STORAGE SPACE AND ITS UTILIZATION

### Storage Capacity and Stocks

The 1956-60 period was used to study adjustments in storing, handling and moving sorghum grain in the State. Under the stimuli of rapidly increased

TABLE 2. OFF-FARM STORAGE CAPACITY ON JANUARY 1, 1955 AND 1960, PERCENTAGE INCREASE IN STORAGE SPACE AND PROPORTION OF TOTAL STATE CAPACITY BY AREAS[1]

| Area | Total off-farm storage space | | 1960 space as a percent of 1955 space | Proportion of total space in the State | |
|---|---|---|---|---|---|
| | 1955 | 1960 | | 1955 | 1960 |
| | — 1,000 bushels — | | — — Percent — — | | |
| High Plains | 132,100 | 310,789 | 235 | 44 | 47 |
| North Central | 107,000 | 165,148 | 154 | 36 | 25 |
| Coastal Bend | 15,300 | 37,881 | 248 | 5 | 6 |
| Others | 45,600 | 145,402 | 319 | 15 | 22 |
| Texas | 300,000 | 659,220 | 220 | 100 | 100 |

[1]Source: Based on data in Texas Grain Storage Statistics, Texas Crop and Livestock Reporting Service, AMS, U. S. Department of Agriculture, Bulletin 5, March 1960. "The capacity totals reflect storage at rice warehouses only to the extent that the storage has been approved by the Commodity Credit Corporation for storing other grains than rice." This does not affect data in the areas studied since no rice is grown and handled in those areas.

TABLE 3. OFF-FARM JANUARY 1 GRAIN STORAGE CAPACITY AND STOCKS, STOCKS AS PERCENT OF CAPACITY, AND KIND OF GRAIN AS A PERCENT OF TOTAL GRAIN STOCKS, TEXAS, 1955-60[1]

| Year January 1 | Storage capacity | Off-farm stocks of grain[2] | Stocks as percent of capacity | Kind of grain as percent of total stocks | | |
|---|---|---|---|---|---|---|
| | | | | Sorghum grain | Wheat | Others |
| | Million bushels | | | Percent | | |
| 1955 | 300 | 214 | 71 | 42.2 | 55.0 | 2.8 |
| 1956 | 320 | 227 | 71 | 47.0 | 50.0 | 3.0 |
| 1957 | 360 | 225 | 62 | 50.3 | 47.2 | 2.5 |
| 1958 | 390 | 313 | 80 | 64.8 | 31.6 | 3.6 |
| 1959 | 567 | 456 | 80 | 69.9 | 27.1 | 3.0 |
| 1960 | 659 | 543 | 82 | 72.6 | 26.2 | 1.2 |

[1]Source: Texas Grain Storage Statistics, Texas Crop and Livestock Reporting Service, AMS, U. S. Department of Agriculture, Bulletin 5, March 1960.
[2]Includes sorghum grain, corn, wheat, oats, barley and rye.

production, the increased carryover stocks each year, and movements of out-of-state CCC stocks into Texas, off-farm storage capacity (excluding facilities handling only rice) increased from 300 to 659 million bushels, Table 2. An estimated 70-million-bushel capacity was added by 1961. Demand for storage space gave much of the impetus to increase capacity.

The areas studied had 85 percent of the State's total storage in 1955 and 78 percent in 1960. The greatest increase in quantity of storage occurred in the High Plains, the largest production area. In 1960 the area had 311 million bushels or 47 percent of the off-farm space. The Coastal Bend had only 6 percent.

While total storage space was mushrooming to more than twice the 1955 capacity, storage stocks were increasing even more rapidly, Table 3. In 1955, the 300-million-bushel capacity was 71 percent occupied while in 1960 the 659-million-bushel capacity was 82 percent occupied.

Grain sorghums and wheat account for more than 97 percent of all stocks in storage. Sorghum grain has steadily increased. In 1955, sorghums occupied about 42 percent of the space and in 1960 about 73 percent, at the expense of wheat. Although the percentage of wheat occupancy declined by more than one-half during the period, the actual amount in storage increased from 118 to 142 million bushels.

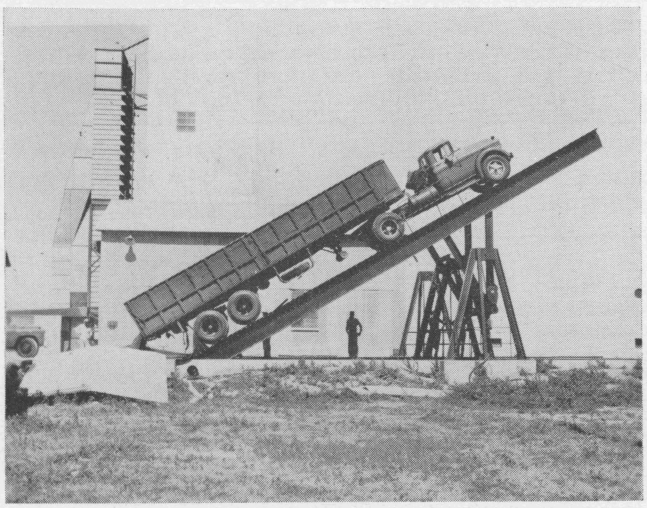

Figure 2. Most elevators are fairly well equipped to handle receipts by truck.

## Additions and New Elevators

The most profitable size of a country grain storage facility depends on demand, as well as cost and technological conditions. The marked increase in total storage capacity and size of individual units was largely in response to changes in the structure of demand for storage.

Formerly the feasible size of a country storage facility was restricted by the amount of grain grown locally and moved into marketing channels. There have been three major changes affecting demand for storage. First, not only has production of grain in local areas increased, but the proportion which moves into marketing channels (especially feed grains) also increased. Second, stocks of Government grain held in storage from year to year increased. Third, out-of-state grain stocks have moved into storage facilities in Texas built along the routes to the export shipping points at Houston, Galveston and Corpus Christi. As a result of these changes, motivation to increase storage facilities was influenced less by local grain production and influenced more by outside forces.

To meet the demand for more storage space, capacity was added to existing facilities and new storage installations were built. Individual storages were larger, indicating an increase in the most profitable size. The 259 million bushels of capacity added from 1955-60 were about evenly divided between new installations and expansion of existing facilities, Table 4.

In the High Plains and Coastal Bend, most new space came from expansion of existing facilities. In North Central Texas, however, more than four-fifths of the additional space came from new storages. Two reasons explain this (1) the ease with which out-of-state stocks can be moved into the areas along trunk

TABLE 4. INCREASE IN STORAGE SPACE BY ADDITIONS TO ELEVATORS EXISTING IN 1955 AND BY NEW ELEVATORS, 1955-60[1]

| Areas | Increase in storage capacity, 1955-60 | | | Proportion of total increase by | |
|---|---|---|---|---|---|
| | By additions to storages existing in 1955 | By new storages built after 1955 | Total increase[2] | Additions | New storages |
| | 1,000 bushels | | | Percent | |
| High Plains | 97,564 | 81,125 | 178,689 | 54.6 | 45.4 |
| North Central | 10,172 | 47,976 | 58,148 | 17.5 | 82.5 |
| Coastal Bend | 14,362 | 8,219 | 22,581 | 63.6 | 36.4 |
| All areas | 122,098 | 137,320 | 259,418 | 47.1 | 52.9 |

[1]Source: Data in the table are based on CCC-approved storage.
[2]The difference between 1955 and 1960 total capacities is shown in Table 2.

TABLE 5. STORAGE SPACE BY PERIOD OF CONSTRUCTION AND TYPE OF STRUCTURE

| Area and type of structure | Storage capacity by period when constructed | | | |
|---|---|---|---|---|
| | Prior to 1956 | | 1956-60 inclusive | |
| | 1,000 bushels[1] | Percent | 1,000 bushels[1] | Percent |
| High Plains | | | | |
| Flat | 29,062 | 22 | 142,951 | 80 |
| Upright | 103,038 | 78 | 35,738 | 20 |
| North Central | | | | |
| Flat | 52,430 | 49 | 44,192 | 76 |
| Upright | 54,570 | 51 | 13,956 | 24 |
| Coastal Bend | | | | |
| Flat | 2,907 | 19 | 20,097 | 89 |
| Upright | 12,393 | 81 | 2,484 | 11 |
| All areas | | | | |
| Flat | 84,399 | 33 | 207,240 | 80 |
| Upright | 170,001 | 67 | 52,178 | 20 |

[1]Quantities given in the table are total storage space quantities allocated in proportions determined from the sample survey.

rail routes, and (2) older facilities predominate in the area and are more difficult to add to because of design, location and limited land for expansion.

In the type of structure built there was a marked shift from upright to flat storage buildings, Table 5. In 1955 about two-thirds of the capacity in the sample areas was upright. Only about one-fifth of the capacity added after 1955 is upright.

Flat structures have several advantages over uprights for storing grain. Less capital investment per bushel of storage is needed, thereby easing credit requirements. Flat storage may be adaptable for other uses when not needed for grain storage. And finally, flat storages are well adapted to the use of aeration.

There also were shifts in the construction materials used for new facilities in the 1956-60 period, Table 6. In flat storages constructed before 1956, about 43 percent of the capacity was steel, 42 percent concrete and the remaining 15 percent divided among wood, wood and steel, and wood and concrete materials. About four-fifths of the upright storage was constructed of concrete.

After 1955 there was a definite swing toward steel in both flat and upright structures except in the High Plains where concrete was used in upright structures. Larger units were built in that area and there was a considerable shift to flat structures. Upright concrete structures were built mainly to maintain what they consider a proper upright to flat space ratio. The general use of steel in all areas is explained mainly by lower initial investment costs, especially in smaller capacities, ease of installing or adding to existing facilities, greater probability and greater potential for shifting to other uses.

Some storage operators stored grain on the ground temporarily in the peak season, while others were forced to refuse storage space—particularly for sorghum grain—in one or more of the years 1956-60. Despite these space shortages only a few operators had definite plans to expand facilities due partly to the increasingly uncertain future demand for storage. Much of the uncertainty was caused by expectations of possible policy changes in the management of CCC grain stocks. Less than 10 percent of the operators had definite plans to increase their storage capacity. More recent developments have justified their reluctance to build additional storage.

### Merchandising and Turning Space

Merchandising space is that used to handle grain brought in for early sale or transfer and held for only a short time. In many facilities 90 percent or more of total space is used throughout the year for grain storage, much of which is more than 1 year old. As the new grain crop comes in, it must either be moved through the merchandising space or old grain must be moved out to make room for the new grain. Most storage operators attempt to keep merchandising space

TABLE 6. STORAGE SPACE BY SPECIFIED MATERIAL AND TYPE OF STRUCTURE[1]

| Area and construction material | Storage built prior to 1956 | | | | Storage built 1956-60 inclusive | | | |
|---|---|---|---|---|---|---|---|---|
| | Flat structures | | Upright structures | | Flat structures | | Upright structures | |
| | 1,000 bushels | Percent | 1,000 bushels | Percent | 1,000 bushels | Percent | 1,000 bushels | Percent |
| High Plains | | | | | | | | |
| Steel | 25,226 | 86.8 | 8,243 | 8.0 | 141,521 | 99.0 | 6,111 | 17.1 |
| Concrete | 1,453 | 5.0 | 86,758 | 84.2 | | | 29,055 | 81.3 |
| Others[2] | 2,383 | 8.2 | 8,037 | 7.8 | 1,430 | 1.0 | 572 | 1.6 |
| North Central | | | | | | | | |
| Steel | 8,389 | 16.0 | 8,185 | 15.0 | 36,017 | 81.5 | 12,630 | 90.5 |
| Concrete | 33,555 | 64.0 | 44,748 | 82.0 | 5,568 | 12.6 | 1,326 | 9.5 |
| Others[2] | 10,486 | 20.0 | 1,637 | 3.0 | 2,607 | 5.9 | | |
| Coastal Bend | | | | | | | | |
| Steel | 2,907 | 100.0 | 4,771 | 38.5 | 20,097 | 100.0 | 2,484 | 100.0 |
| Concrete | | | 7,362 | 59.4 | | | | |
| Others[2] | | | 260 | 2.1 | | | | |
| All areas | | | | | | | | |
| Steel | 36,522 | 43.3 | 21,199 | 12.5 | 197,635 | 95.4 | 21,225 | 40.7 |
| Concrete | 35,008 | 41.5 | 138,868 | 81.7 | 5,568 | 2.7 | 30,381 | 58.2 |
| Others[2] | 12,869 | 15.2 | 9,934 | 5.8 | 4,037 | 1.9 | 572 | 1.1 |

[1]Sample proportions were applied to total storage capacities by areas to obtain estimates of quantities in the table.
[2]Includes wood, steel and concrete and steel and wood structures.

**Figure 3. Aeration was adopted at a rapid rate after its development. A majority of elevators now have all or part of their facilities equipped for aeration.**

at a minimum to store as much grain as possible and at the same time receive all grain delivered to their facilities at harvest to maintain "good will."

Operators with no aeration facilities, or insufficient facilities to care for total capacity, need vacant space to turn their grain while it is in storage. Too, many operators with aeration facilities still practice turning. If turning is not required during the harvest season, space used for merchandising can later be used for turning. Although operations of merchandising and turning may supplement each other, the storage operator under normal conditions considers storage utilization capacity as somewhat less than total storage capacity.

Storage operators estimated that slightly less than 6 percent of the total space in 1960 was needed for merchandising and turning. Individual estimates varied, depending on the extent of their merchandising activities and their needs for turning.

Turning is more commonly practiced in the High Plains and, since harvest occurs later, more grain is stored and less merchandised than in other areas. Apparently, merchandising activity by storage operators in North Central Texas is important. Several operators estimated more than one-fourth of their space was needed for that purpose.

### Use of Storage Space

The use of grain storage facilities in Texas is characterized by (1) the dominance of sorghum among the grains stored, (2) the heavy role of the CCC in storage operations and (3) the large proportion of space used for carryover stocks, mostly grains already forfeited to CCC. These conditions vary in intensity but are sufficiently prevalent in all areas to justify some concern with the effect of government programs to reduce production and carryover stocks on the grain storage industry.

Facilities were used at or near capacity levels during the peak of the season in both 1955 and 1960, Table 7. Slightly less than three-fourths of all grain stored in 1955 was sorghum and this increased to four-fifths by 1960. With minor exceptions, sorghum is the only grain stored in the Coastal Bend, wheat is the main competitor for storage space in the High Plains, and corn, wheat and other grains compete in North Central Texas.

Sorghums held by CCC, both under loan and forfeited, were slightly less than four-fifths of all sorghum stored in 1955 and slightly more than four-fifths in 1960. Considerable amounts of sorghum in storage are carryover stocks, mostly CCC grain, that have been in storage for some time. An estimated 115 of the 398 million bushels of sorghum stored in 1960 were more than 2 years old, Table 8. Only 17 percent of all sorghum stored in the High Plains, compared with about half in the other two areas, was more than 2 years old.

**TABLE 7. USE OF STORAGE SPACE BY SORGHUMS AND OTHER GRAINS AT PEAK OF SEASON, 1955 AND 1960[1]**

| Area and year | Total storage space | Space used for all grains at peak | | Space used for sorghum grain at peak | | Ratio of sorghum to all grains stored | Space used for sorghum held by CCC[2] | Ratio of sorghum held by CCC to total stored |
|---|---|---|---|---|---|---|---|---|
| | 1,000 bushels | 1,000 bushels | Percent | 1,000 bushels | Percent | Percent | 1,000 bushels | Percent |
| High Plains | | | | | | | | |
| 1955 | 132,100 | 125,495 | 95 | 97,754 | 74 | 77 | 60,766 | 62 |
| 1960 | 310,789 | 304,573 | 98 | 242,415 | 78 | 80 | 195,797 | 81 |
| North Central | | | | | | | | |
| 1955 | 107,000 | 104,860 | 98 | 66,340 | 62 | 63 | 56,710 | 85 |
| 1960 | 165,148 | 160,194 | 97 | 120,558 | 73 | 75 | 105,695 | 88 |
| Coastal Bend | | | | | | | | |
| 1955 | 15,300 | 14,382 | 94 | 14,382 | 94 | 100 | 13,158 | 91 |
| 1960 | 37,881 | 34,851 | 92 | 34,851 | 92 | 100 | 31,441 | 90 |
| All areas | | | | | | | | |
| 1955 | 254,400 | 244,737 | 96 | 178,476 | 70 | 73 | 137,054 | 77 |
| 1960 | 513,818 | 499,618 | 97 | 397,824 | 77 | 80 | 332,933 | 84 |

[1]Proportions were determined from the sample study. Quantities were determined by exterpolating these percentages to total storage space in the areas for the years specified.
[2]Includes grain both under loan and forfeited to CCC.

TABLE 8. STOCKS OF SORGHUM GRAIN STORED MORE THAN 2 YEARS, 1960[1]

| Area | Sorghum grain stored over 2 years | | Storage installations with sorghum stored over 2 years | |
|---|---|---|---|---|
| | 1,000 bushels | Percent | Number | Percent |
| High Plains | 41,211 | 17 | 133 | 38 |
| North Central | 55,457 | 46 | 117 | 67 |
| Coastal Bend | 18,471 | 53 | 42 | 83 |
| All areas | 115,139 | 29 | 292 | 51 |

[1]Percentage figures in the table are computed from the study sample. Quantity figures are exterpolations based on the sample percentages applied to the total sorghum grain stored and number of elevators.

### Movement of Sorghum Grain from Storages

The movement pattern of sorghum grain from local storage installations to different market outlets was modified after World War II. In part this occurred in response to the changing demand structure for feed grain in general and sorghum grain in particular.

The rather straightforward local-terminal-mill or export movement of grain that formerly was characteristic of the grain trade was already disrupted by 1955. About two-fifths of the sorghum grain handled in 1959 moved to terminal and other storage installations, and one-fourth directly to export. A large proportion of this was CCC stocks moved at government request, Table 9. Movement to other storage installations represents the government's efforts to clear space for new grain before harvest and the rather constant pressure of growing stocks on the limited storage space during the 1950's. Many so-called "local" storage installations performed functions comparable with those that formerly characterized the terminal installation operation.

Terminal and other storage installations were the most important outlet for sorghum grain handled in the High Plains in both 1955 and 1959, whereas export was more important in the other two areas. While the proportion of total sorghum grain handled that went into exports was lower in 1959 than in 1955 in all areas, the total quantity exported in 1959 was greater. There was considerably more sorghum grain handled overall in 1959 than in 1955.

There was an increase in the proportion sold directly to feeders from 1955 to 1959 in the High Plains. This reflects an increase in feeding operations in that area in recent years. There were more sales to truckers in the High Plains than in the other two areas. This reflects truck movement of sorghum grain from the area to Arizona and California markets. Feed mills were a significant outlet for sorghum grains in North Central Texas because of a heavy concentration of feed milling in the area. Quite a few local feed mills in the area are associated with grain storage operations.

Terminals are well established in the High Plains. Most of the cooperative elevators are tied in with terminals which pay patronage refunds. They should continue to be an important outlet in that area. Feeding operations will probably continue to expand in Arizona and California and locally in the area. As a consequence, the trend toward direct sales to feed dealers will probably continue.

Some have speculated about the integration of feeding operations with commercial grain storage in the High Plains. Decreasing carryover stocks and increasing amounts of unused storage may induce efforts toward both integration and "grain bank" operations. These could become important in other areas as well, especially if future livestock prices are favorable relative to grain prices.

## HANDLING FACILITIES AND PRACTICES

The type of equipment used and practices followed by storage operators in receiving, handling, storing and loading out grain affect the operational cost and the ability to adequately handle peak season movements. This study was designed to indicate equipment and practices most commonly used and their variations among storage units and between areas. Results do not reflect relative efficiency. Information will complement the more detailed cost

TABLE 9. DISPOSAL OF SORGHUM GRAIN HANDLED IN 1959

| Disposal outlet | Disposal of sorghum grain handled[1] | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | High Plains | | North Central | | Coastal Bend | | All areas | |
| | 1,000 bushels | Percent | 1,000 bushels | Percent | 1,000 bushels | Percent | 1,000 bushels | Percent |
| Shipped to terminal and other storages | 15,828 | 61 | 1,849 | 21 | 601 | 7 | 18,278 | 42 |
| Used in own feed mill | 260 | 1 | 440 | 5 | [2] | [2] | 700 | 2 |
| Sold to other feed mills | [2] | [2] | 1,233 | 14 | [2] | [2] | 1,233 | 3 |
| Sold direct to feeders | 2,854 | 11 | 176 | 2 | 86 | 1 | 3,116 | 7 |
| Sold to truckers | 1,297 | 5 | 88 | 1 | | | 1,385 | 3 |
| Export | 3,892 | 15 | 2,729 | 31 | 5,239 | 61 | 11,860 | 27 |
| Remained in storage | 1,816 | 7 | 2,025 | 23 | 2,577 | 30 | 6,418 | 15 |
| Other | [2] | [2] | 264 | 3 | 86 | 1 | 350 | 1 |
| Total | 25,947 | 100 | 8,804 | 100 | 8,589 | 100 | 43,340 | 100 |

[1]Data computed from that provided by those storages in the study that provided sufficient information to allocate the grain sorghum they handled to the different outlets.
[2]Figures that were less than one-half of one percent of the total in each area were discarded in the analysis.

TABLE 10. RECEIPTS AND SHIPMENTS OF SORGHUM GRAIN BY TYPE OF TRANSPORTATION, 1955 AND 1959

| Area | Rail | | Truck | |
|---|---|---|---|---|
| | 1955 | 1959 | 1955 | 1959 |
| | Percent | | | |
| | Receipts | | | |
| High Plains | 11 | 6 | 89 | 94 |
| North Central | 78 | 63 | 22 | 37 |
| Coastal Bend | 18 | 7 | 82 | 93 |
| All areas | 22 | 18 | 78 | 82 |
| | Shipments | | | |
| High Plains | 78 | 68 | 22 | 32 |
| North Central | 89 | 86 | 11 | 14 |
| Coastal Bend | 66 | 68 | 34 | 32 |
| All areas | 78 | 72 | 22 | 28 |

studies of alternative handling methods to be conducted later.

### Amounts of Sorghum Grain Handled

Equipment and practices used for receiving, moving and loading out grain is determined in part by the amounts handled during a season. Amounts of sorghum grain handled by individual storage installations were greater than the amounts stored in some installations and less in others in 1959. Some operators moved considerable amounts of sorghum in and out of their facilities in merchandising operations and, if carryover stocks were light, moved considerable amounts of new grain into storage. Others that merchandised very little grain and had large carryover storage stocks from the previous year handled less sorghum grain than they stored. For all installations sorghum grain handled was estimated at slightly more than three-fourths the amount stored.

In general, smaller storages handled more than they stored and larger ones handled less in all areas. The smaller storages apparently depend more on servicing the trade of local-grown grain in their total operation. Consequently, they have a high ratio of merchandising trade to storage capacity and large seasonal turnover in stocks. The larger installations generally have considerable space filled with CCC carryover stocks and handle local-grown grain more on a supplementary basis.

From 60 to 75 percent of the installations in the areas studied handled less than half a million bushels of sorghum grain, 15 to 30 percent handled between one-half and a million bushels and about 10 percent handled more than a million bushels.

### Receipts and Shipments by Type of Transportation

About four-fifths of the sorghum grain receipts were by truck, whereas about three-fourths of their shipments out were by rail, Table 10. There was a slight increase in truck transportation as a proportion of both total receipts and total shipments during 1955-59. This supports the widely held opinion that trucks are being used for longer hauls to a greater extent than formerly. An example of this is truck shipments of sorghum grain from the High Plains to Arizona and California.

The high proportion of sorghum grain received by rail in North Central Texas suggests that a large part of their storage continues to serve as reservoirs for grain shipped in from other areas. The greater proportion of new facilities in their recently increased storage space is compatible with this explanation. Several operators indicated the new facilities were filled with CCC stocks of grain.

### Receiving and Loading Out Facilities

The type and capacity of receiving and loading out equipment in use at storage installations are determined in part by the kind of transportation in which grain is received and shipped and by the volume of grain handled during the peak season. In part, too, they represent additions to, and adaptations of, equipment obtained in earlier years under different anticipated handling conditions and requirements than presently prevail. More and more of the storage installations are being adapted to handle both rail and truck in receiving as well as shipping grain.

About one-third of the storage installations had only one dump available for receiving grain while the rest had two or more. In general, a higher proportion of the larger installations had two or more dumps than the smaller ones, although one-fifth of those in excess of 1-million-bushel capacity had only one dump. The larger storages tend to have a lower ratio of grain handled to total storage capacity than the smaller ones. Therefore, the need for particular kinds of equipment does not necessarily increase proportionately with size.

The number and capacity of receiving and loading conveyers also varied rather widely between storage installations. The average amount of grain that could be received or loaded out per hour increased from storages of less than half-a-million-bushel capacity to those in excess of a million-bushel-storage capacity. The range in capacity per hour in each size category, however, was quite wide. Some installations with less than half-a-million-bushel-storage capacity had greater receiving capacities per hour than others with more than a million-bushel-storage capacity. In general, installations in the High Plains tended to have greater receiving capacity per hour in comparable size categories than those in the other two areas.

Capacity per hour for receiving grain ranged from less than 1,000 bushels per hour to 40,000 bushels per hour among storages, Table 11. About three of every ten had receiving conveyers sufficient to receive from 3,000 to 6,000 bushels per hour and about three of every four could receive from 1,500 bushels to 12,000 bushels per hour.

Operators normally do not face the pressure for loading out grain they face in peak season receipts.

However, a high proportion have the same capacity for loading out as receiving grain with only 15 percent having less.

The dominant type of conveying equipment reported for receiving grain was the bucket elevator. Many flat as well as upright storage units have bucket elevators.

Many operators consider conveyer equipment for receiving in terms of the initial operation which excluded the distribution of the grain to storage bins. It is quite common, especially for grain which is to be dried, to pick up the grain directly from the receiving dump pit with a bucket elevator and drop it by gravity flow into a nearby bin or tank (the green grain bin). Horizontal conveyer belts and augers are used to distribute the grain to storage bins.

Belts, augers and pneumatic conveyers were also used, either in combination with other types or singly, as receiving equipment by a number of installations and drag conveyers and gravity flow were used by a few. Operators in North Central Texas used a greater variety of receiving conveyers, and a higher proportion used two or more types, than in the other two areas.

In general, conveyer equipment used for loading out was similar to that for receiving, although two or more types were used more frequently than for receiving. The pneumatic conveyer, belt and augers were more frequently used for loading out than for receiving, although the pneumatic conveyer was used mainly by storage installations in North Central Texas. The greater variation of conveyer equipment for receiving and loading out was likely due to the greater role of rail transportation in that area.

Platform scales were used in weighing grain receipts by most storage installations. However, more of the operators in North Central Texas reported using railroad scales than platform scales for weighing receipts and one of every four had two or more types available. A higher proportion of railroad scales than other types was used for weighing grain shipments in all areas, although half the operators in the High Plains and about one-fourth in the other two areas reported two or more types available.

Most operators in all three areas used the cradle hoist to unload grain from trucks and the power shovel to unload railroad cars. However, a few operators in North Central Texas reported car dumps and pneumatic conveyers for unloading railroad cars.

### Labor Requirements to Receive and Load Out

Labor requirements were related to receiving and load-out capacities per hour, by rail and truck, Table

Although indicated requirements varied by size of storages, there was a discernible pattern in the data. In general the number of men required increased as the capacity to receive and load out increased for both truck and rail although requirements declined substantially per 1,000 bushels. The average tended to be somewhat higher by rail than by truck for both receiving and loading out in comparable sizes. Quite a few operators indicated the same men requirements for truck and rail. But in general operators that had both truck and rail receipts and shipments involved, and indicated their labor requirements, tended to estimate higher requirements for rail when the two differed. Only a few indicated lower requirements.

**TABLE 11. CAPACITY PER HOUR OF RECEIVING AND LOADING LEGS BY SPECIFIED ELEVATOR SIZE CATEGORIES AND AREAS**

| Capacity categories | Average capacity per hour | | |
|---|---|---|---|
| | High Plains | North Central | Coastal Bend |
| | — — — Bushels per hour — — — | | |
| | — — Receiving legs of elevators — — | | |
| Less than 500,000 bushels | 4,606 | 2,425 | 2,077 |
| 500,000 - 999,999 bushels | 8,231 | 10,600 | 4,691 |
| 1,000,000 bushels and over | 15,464 | 10,927 | 4,446 |
| | — — Loading legs of elevators — — | | |
| Less than 500,000 bushels | 4,253 | 2,400 | 1,854 |
| 500,000 - 999,999 bushels | 7,385 | 6,240 | 4,101 |
| 1,000,000 bushels and over | 13,036 | 10,927 | 4,446 |

**TABLE 12. MEN REQUIREMENTS TO RECEIVE AND LOAD OUT GRAIN SORGHUM BY TRUCK AND RAIL AND BY RECEIVING AND LOADING OUT CAPACITIES PER HOUR[1]**

| Capacity per hour | Elevators reporting | Average capacity | Average men requirements | |
|---|---|---|---|---|
| | | | Per elevator | Per 1,000 bushels per hour capacity |
| | Number | Bu./hr. | Number | Number |
| Receipts: Truck | | | | |
| Less than 4,000 bushels | 28 | 2,080 | 3.32 | 1.60 |
| 4,000 - 7,999 bushels | 26 | 5,159 | 4.42 | .86 |
| 8,000 bushels and above | 20 | 14,850 | 6.70 | .45 |
| Rail | | | | |
| Less than 4,000 bushels | 17 | 1,821 | 4.06 | 2.23 |
| 4,000 - 7,999 bushels | 10 | 4,588 | 4.40 | .96 |
| 8,000 bushels and above | 8 | 15,250 | 7.12 | .47 |
| Shipments: Truck | | | | |
| Less than 4,000 bushels | 21 | 1,970 | 2.48 | 1.26 |
| 4,000 - 7,999 bushels | 17 | 4,800 | 2.53 | .53 |
| 8,000 bushels and above | 16 | 12,531 | 4.25 | .34 |
| Rail | | | | |
| Less than 4,000 bushels | 33 | 1,989 | 3.15 | 1.58 |
| 4,000 - 7,999 bushels | 24 | 4,853 | 3.67 | .76 |
| 8,000 bushels and above | 18 | 13,389 | 5.78 | .43 |

[1]Data based on estimates of requirements by storage operators and should not be interpreted as standards of efficiency.

TABLE 13. PROPORTION OF STORAGE OPERATORS THAT TEST SORGHUM GRAIN RECEIPTS FOR SPECIFIED FACTORS BY AREAS

| Area | Kind of test | | | | |
|---|---|---|---|---|---|
| | Moisture | Foreign matter | Test weight | Insects | Condition |
| | Percent | | | | |
| High Plains | 100 | 52 | 75 | 77 | 91 |
| North Central | 100 | 77 | 92 | 100 | 96 |
| Coastal Bend | 100 | 22 | 78 | 56 | 83 |

Data concerned with equipment for receiving and loading out grain, presented earlier, suggest the slightly higher men requirements for rail receipts and shipments is probably due to the types of equipment used—which were not the most labor-saving type for rail handling at most of the storage installations. Most installations apparently are better equipped to handle grain by truck than by rail. The ease of handling trucks is a factor and higher investments are required for the more mechanical handling of rail cars.

## QUALITY MAINTENANCE IN STORAGE

To preserve the market value of stored grain, certain preventive measures are necessary. Loss in germination and certain alterations in chemical composition occur slowly, even under good storage practices, and are not readily discernible. The storage operator is not usually concerned with these unless they progress fast enough to cause loss in market value. Other changes caused by insect damage or mold growth tend to spread rapidly, are readily discernible and can cause considerable market loss if not avoided or controlled.

This phase of the report concerns the quality control practices used by storage operators in the areas studied. The areas were selected initially to provide a wide range in grain and weather conditions that induce quality deterioration. The quality control practices in use probably reflect storage operator's response to the intensity of these hazards over time in each of the areas.

### Tests Prior to Storage

Sorghum grain, when received, normally is tested for factors that influence its market value and storability. Factors tested for include moisture content, test weight, insect infestation, foreign material (including other grain and finely broken sorghum kernels) and condition. Moisture and test weight are determined by objective tests using mechanical equipment while the others are by visual observations with findings based on experienced judgment.

Not all sorghums are tested for the same factors, Table 13. Whether tests are made on specific factors is an indication of past difficulties. The difficulties experienced with various factors depend not only on the grain when received, but also on the condition of structures used for storage, availability of facilities needed to maintain market value and the effectiveness of preventive measures. All storages are not equal in this respect. Recently built storages may have the advantage of more modern and efficient facilities to prevent deterioration.

Moisture and condition are considered the most important factors because they are reliable indications of storability. All operators in all areas made moisture tests of each lot received and more than 90 percent of them inspected for condition. Among the areas, the North Central area uses the complete range of tests most often. Statewide, fewer operators test for foreign material than for any other factor, and its use varies widely among the areas (77 percent, North Central; 52 percent, High Plains; 22 percent, Coastal Bend). Part of this variation may be explained by the final disposition of the sorghums. For example, a high foreign material content made up of cracked sorghum kernels and other grain might be acceptable without discount to a feed mixer but unacceptable to an exporter.

Slightly less than half the operators in the High Plains and about one-third in the other areas said they segregated sorghum grains for storage on the basis of particular tests. Moisture content was the main basis used. In addition, insect infestation and test weight were the next two most frequently used for segregation in the High Plains and insect infestation and foreign matter were most frequently used in North Central Texas.

### Acceptable Moisture Content by Storage Operators

Although moisture content is a major factor in maintaining the market value of stored grain sorghums, there is a wide difference in the moisture content of grain delivered for storage. The maximum moisture level accepted without a drying discount varies among storage operators both within and between areas. The operator's willingness to accept grain with high moisture without drying charge is affected by (1) the intensity of competition to fill storage space, (2) his ability to move a portion of the grain directly into feed mill markets where no price discount is incurred up to 15 percent moisture, (3) climatic conditions such that he feels he may safely store grain with higher moisture and decrease it to acceptable levels by aeration and turning and (4) his opportunity to blend high moisture grain with receipts having low moisture content to attain a safe level for storage. However, when blending or moving direct to feed markets is not possible, those that accept grain for storage in excess of 13 percent moisture without a drying charge presumably absorb the costs of drying, or the increased risk of loss due to higher moisture, in their returns from storage.

In the High Plains, sorghums were accepted at higher maximum moisture levels without a drying charge than in the Coastal Bend and North Central Texas. Four-fifths of the operators in the High Plains

had maximum moisture levels without charge higher than 13 percent and a few of these had maximum levels above 15 percent. Less than one-fourth of the operators in North Central Texas and the Coastal Bend had maximum levels without charge higher than 13 percent and none over 15 percent.

### Drying and Aeration

Artificial drying of grain when delivered for storage has been practiced for many years in the Coastal Bend where moisture is an acute problem. Only in the past 7 years have operators in other parts of the State felt it necessary to dry grain delivered for storage.

Almost three-fourths of the storages in the High Plains have drying facilities. Less than one-fourth have them in North Central Texas. This explains in part why operators in that area are more particular in testing grain receipts and have lower maximum levels of moisture acceptable for storage than in the High Plains. Many storage operators in the North Central area said they did not need drying facilities because grain is sufficiently field dried for safe storage. Probably discounts and refusal to accept high moisture grain by storages in the area have affected producers' willingness to field dry.

About 70 percent of the storage facilities in the Coastal Bend dried three-fourths or more of the sorghum grain received for storage. None of them dried less than one-fourth. Only 11 percent in the High Plains and none in North Central Texas dried three-fourths or more of their stored grain. However, almost three-fourths of the operators in the High Plains and slightly less than one-fifth of them in the North Central area did dry some of the grain received for storage.

The continuous flow type of drier with heated air was about twice as numerous as the batch drier with heated air among the storages studied. No other type was significant. Too, there was little difference in the proportions of the continuous flow and batch type by areas.

Aeration is considered of major importance as a means of maintaining market value of sorghum grain during storage and has been accepted rapidly throughout Texas since its development in the early 1950's. Its main advantage is that the need for turning is eliminated thereby providing maximum use of space. The popularity of aeration is shown by the fact that in 1960 (1) two-thirds of the total storage space in the High Plains and four-fifths of the space in the other areas is equipped for aeration; (2) about 90 percent of all storages are equipped to aerate at least part of their space with about two-thirds of them capable of aerating almost all of it.

Most aeration is on an "as needed" basis rather than on a calendar schedule with reliance placed on experienced judgment of the need to aerate. Factors most usually considered in deciding when to aerate are: (1) the development of "hot spots," (2) average moisture content, (3) differential between grain and outside temperatures and (4) weather conditions.

TABLE 14. FUMIGATION PRACTICES BY AREAS

| Type of practice | Proportion of operators that fumigate using specified practices | | |
|---|---|---|---|
| | High Plains | North Central | Coastal Bend |
| | — — — — Percent — — — — | | |
| Service performed by | | | |
| Elevator personnel | 77 | 75 | 89 |
| Commercial firms | 23 | 25 | 11 |
| Means of fumigating | | | |
| Gravity | 45 | 24 | 25 |
| Aeration system | 29 | 52 | 75 |
| Both | 26 | 24 | 0 |
| System used | | | |
| Single pass | 50 | 54 | 27 |
| Recirculate | 26 | 33 | 67 |
| Both | 24 | 13 | 6 |

While the need for turning is supposed to be eliminated by aeration, the practice still persists in aerated facilities. More than half of the operators in the High Plains and a fourth of those in other areas, with equipment to aerate their sorghums, also turned them. Some is turned soon after binning, other is turned at intervals of 3 or 6 months and the rest is turned "as needed." In storages with only part of their space aerated, the unaerated grain was turned more often. When sorghums are turned soon after binning, the purpose usually is to add a protectant against insect infestation. This should not be considered as an adjunct to aeration.

About one-third of the storage facilities were equipped with automatic temperature sensing systems. Deep bin probing was the method most commonly used in the absence of automatic systems.

### Insect Control in Stored Sorghum Grain

About one-fourth of the operators applied a protectant, usually malathion, when the grain was moved into storage. Fumigation to control insect infestation while the grain was in storage was practiced by most operators.

Most storage operators use their own personnel to fumigate. However, about one-fourth in the High Plains and North Central areas and one-tenth in the Coastal Bend hired commercial firms to perform the service, Table 14. Most of those that used commercial service were larger storages. Too, a few used commercial service for only part of their facilities and serviced the rest themselves. Apparently, commercial service was used when the task was more than usually difficult and required the service of a specialist.

Methods employed in fumigating varied considerably among storage operators. Except in the Coastal Bend where three-fourths used their aeration systems and "recirculate" the fumigant, there was

little pattern. The fumigant can be "recirculated" by an aeration system if ducts are run from the top of the bin down to re-enter the main line aeration ducts. Most of those that use their aeration system for fumigating have installed such ducts. However, some still make a "single pass" by allowing time for the fumigant to be forced from the bottom up through the grain to the top of the bin and cutting off the system. Whether they make a "single pass" or "recirculate" depends to some extent on the type of fumigant used. Some storage operators equipped to do so employ the "single pass" sometimes and "recirculate" at others. Other operators employ both methods because they have only a part of their storage space aerated and equipped to "recirculate."

Two respondents used only a surface treatment on all their stored grain and four others used only a surface treatment on part of their stored grain to prevent Indian meal moth infestation.

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**Location of field research units of the Texas Agricultural Experiment Station and cooperating agencies**

# State-wide Research

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**The Texas Agricultural Experiment Station is the public agricultural research agency of the State of Texas, and is one of the parts of the A&M College of Texas.**

## OPERATION

IN THE MAIN STATION, with headquarters at College Station, are 13 subject-matter departments, 3 service departments, 3 regulatory services and the administrative staff. Located out in the major agricultural areas of Texas are 20 substations and 10 field laboratories. In addition, there are 13 cooperating stations owned by other agencies. Cooperating agencies include the Texas Forest Service, Game and Fish Commission of Texas, Texas Prison System, U. S. Department of Agriculture, University of Texas, Texas Technological College, Texas College of Arts and Industries and the King Ranch. Some experiments are conducted on farms and ranches and in rural homes.

## ORGANIZATION

THE TEXAS STATION is conducting about 450 active research projects, grouped in 25 programs, which include all phases of agriculture in Texas. Among these are:

Conservation and improvement of soil
Conservation and use of water
Grasses and legumes
Grain crops
Cotton and other fiber crops
Vegetable crops
Citrus and other subtropical fruits
Fruits and nuts
Oil seed crops
Ornamental plants
Brush and weeds
Insects
Plant diseases
Beef cattle
Dairy cattle
Sheep and goats
Swine
Chickens and turkeys
Animal diseases and parasites
Fish and game
Farm and ranch engineering
Farm and ranch business
Marketing agricultural products
Rural home economics
Rural agricultural economics

Two additional programs are maintenance and upkeep, and central services.

*Research results are carried to Texas farmers, ranchmen and homemakers by county agents and specialists of the Texas Agricultural Extension Service*

**AGRICULTURAL RESEARCH seeks the WHATS, the WHYS, the WHENS, the WHERES and the HOWS of hundreds of problems which confront operators of farms and ranches, and the many industries depending on or serving agriculture. Workers of the Main Station and the field units of the Texas Agricultural Experiment Station seek diligently to find solutions to these problems.**

*Today's Research Is Tomorrow's Progress*